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Awareness of radiation protection and dose levels of imaging procedures among medical students, radiography students, and radiology residents at an academic hospital: Results of a comprehensive survey

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ABSTRACT

Purpose: To evaluate the awareness of radiation protection issues and the knowledge of dose levels of imaging procedures among medical students, radiology residents, and radiography students at an academic hospital.
Material and methods: A total of 159 young doctors and students (including 60 radiology residents, 56 medical students, and 43 radiography students) were issued a questionnaire consisting of 16 multiple choice questions divided into three separated sections (i.e., demographic data, awareness about radiation protection issues, and knowledge about radiation dose levels of common radiological examinations).
Results: Medical students claimed to have at least a good knowledge of radiation protection issues more frequently than radiology residents and radiography students (94.4% vs 55% and 35.7%, respectively; $P < 0.05$), with no cases of perceived excellent knowledge among radiography students. However, the actual knowledge of essential radiation protection topics such as regulations, patient and tissue susceptibility to radiation damage, professional radiation risk and dose optimisation, as well as of radiation doses delivered by common radiological procedures was significantly worse among medical students than radiology residents and radiography students ($P < 0.05$). Those latter significantly outperformed radiology residents as to knowledge of radiation protection issues ($P < 0.01$). Overall, less than 50% of survey respondents correctly answered all questions of the survey.
Conclusions: Radiology residents, radiography students and medical students have a limited awareness about radiation protection, with a specific gap of knowledge concerning real radiation doses of daily radiological examinations. Both undergraduate and postgraduate teaching needs to be effectively implemented with radiation safety courses.

1. Introduction

The recent dramatic evolution and increased use of ionising radiation-based diagnostic modalities such as multidetector computed tomography (CT) has led to a multiplication of the number of examinations and hence of the overall radiation exposure to the population, with CT currently accounting for about 50% of the total radiation burden for medical purposes [1,2]. This situation has raised concerns in the scientific community about the potential side effects on patients, with particular reference to radiation-related cancer and death [2,3]. Moreover, several papers have recently shown a small, but significant increase of cancer risk in children and young patients with previous exposure to CT scans [3–5], paralleled by a measurable increase in radiation-induced DNA damage following several radiologic examinations that correlates with radiation dose [6,7]. In this setting, a full awareness of radiation protection issues and a proper knowledge of the radiation doses delivered by

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the various imaging modalities are essential to make sure that all involved professionals adhere to up-to-date appropriateness and optimisation criteria [8].

General training about radiation protection should be provided starting from undergraduate courses and followed by specific update courses, as requested by the Guidelines on radiation protection education and training of medical professionals in the European Union no. 175 (2014), which has set the standard of minimum knowledge expected from each and every practitioner involved in radiation protection [9]. In the past decade, several studies conducted on selected cohorts of referring physicians and staff radiologists and technologists unveiled an alarming lack of radiation protection knowledge among them. In particular, a substantial amount of professionals resulted to be underestimating the overall radiation doses associated with various imaging modalities, and in some cases, they were even unable to correctly differentiate between ionising and non-ionising radiation-based imaging techniques [10–12]. Such disappointing findings warrant a systematic, comprehensive evaluation of the knowledge of basic radiation protection issues needed for daily practice by students in training (such as medical students, radiography students, and radiology residents), in an attempt to gain insight about the current status of radiation protection education among those who will order, perform or interpret medical imaging examinations in their future professional life. In this perspective, the advantages of creating a positive radiation safety culture in the higher education and research sectors have been outlined, with continuous education and testing for all people involved (including students during their training period) being key to optimise performance, minimise errors, and protect the entire workforce as well as the general public and the environment [13–15].

The aim of our work is to assess the degree of subjectively perceived knowledge and effective knowledge of essential radiation protection and dose assessment topics across a population of medical students, radiography students and radiology residents.

2. Material and methods

2.1. Data collection

Data were obtained from a survey conducted in a group of Radiology residents and undergraduate students by a multidisciplinary "dose team" between January 1 and December 31, 2015. The survey was designed to assess the knowledge of dose exposure levels and awareness of radiation protection among radiology residents, medical students, and radiography students. Questionnaires were distributed on the occasion of university classes that medical students attend during the 5th year of their six-year course, radiography students during the 2nd year of their three-year course, and radiology residents during their five-year course, respectively. Prior to the survey, participants had been informed that the results of the questionnaire would be stored in a database and used for research purposes only. Participation to the survey was voluntary and completely anonymous.

A total of 159 young doctors and students (radiology residents 37.74%, medical students 35.22%, radiography students 27.04%) joined the survey. This latter was divided into three sections, of which:

- Section 1 (Demographics and Perceived radiation protection skills) contained the demographic data of each survey participant, as well as including their degree of training and perceived radiation protection knowledge;
- Section 2 (Radiation protection awareness) was focused on assessing: (1) radiation standards (2) susceptibility to radiation damage, (3) regulations, (4) knowledge about professionals with a higher exposure risk, (5) tissues more susceptible to injury from ionising radiation, (6) diseases caused by radiation damage, and (7) knowledge about dose optimisation;
- Section 3 (Knowledge about radiation dose levels) investigated specific topics, such as: (1) average dose of a postero-anterior chest X-ray (considered as a common reference unit to compare radiation exposure from different radiological examinations); (2) background radiation dose absorbed by the general population; (3) lumbar spine X-ray dose; (4) mammography dose (bilateral, two projections per side); (5) chest CT dose; (6) pelvic magnetic resonance imaging (MRI) dose; (7) 18-fluorodeoxiglucose positron emission tomography-computed tomography (^{18}F-FDG PET-CT) dose; (8) abdominal ultrasound (US) dose; (9) myocardial scintigraphy dose (2-day protocol with ^{99m}TC-sestamibi) [16].

All questions of Sections 2 and 3 were formulated in a multiple choice format with five to six options and one only correct answer. One mark was assigned for each correct answer and zero marks for each wrong or missing answer, respectively (Appendix).

2.2. Statistical analysis

A descriptive analysis of the sample was performed. Categorical variables were expressed as percentages, and continuous variables as mean and standard deviation, respectively. The total questionnaire score and the two subscales (Radiation Protection and Dose Assessment) were expressed as median and interquartile ranges (IQR) and displayed on box-plot diagrams.

The score differences related to three questionnaire sections among the three groups (radiology residents, medical students, radiography students) were evaluated using the Kruskal-Wallis test. Post-hoc analysis was performed using pairwise Mann–Whitney tests with Bonferroni correction. The questionnaire reliability was assessed in terms of internal consistency by means of the Cronbach's alpha (α) coefficient [mean and 95% confidence intervals (CI_{95})].

A P-value less than 0.05 was set as threshold for statistical significance. Statistical analysis was carried out using software (SPSS version 23.0, http://www-01.ibm.com/software/analytics/spss).

3. Results

The demographics of the survey participants in terms of age and gender distribution, perceived radiation protection knowledge, and previously performed training are reported in Table 1. All 159 participants completed the questionnaire. Mean age was 29.4, 23.8, and 22.5 years old for radiology residents, medical students and radiography students, respectively. Gender distribution was comparable across the three categories (43.1%, 48.2%, and 44.2% of male percentage, respectively; Chi-square test, $P > 0.05$).

As reported in a previous paper of ours [16], the questionnaire was found to have acceptable internal reliability ($\alpha = 0.780$; CI_{95} $0.762 \div 0.852$) as a measure of knowledge of essential radiation protection topics. The internal consistency of the questionnaire was also assessed separately among the radiology residents, medical students, and radiography students. Cronbach's α coefficients were 0.760 (CI_{95} $0.746 \div 0.796$), 0.727 (CI_{95} $0.688 \div 0.744$) and 0.797 (CI_{95} $0.696 \div 0.835$), respectively.

As to the perceived knowledge of radiation protection issues, medical students claimed to have at least a good knowledge in 94.4% of cases (22.2% excellent, 72.2% good), resulting in the highest value among the other categories of survey participants. In fact, radiology residents claimed to have at least a good knowledge in 55% of cases (5% excellent, 50% good),